Reply to anonymous Referee #1

Remo Dietlicher

December 22, 2017

Thank you very much for thoroughly reading our manuscript and pointing out some of the inconsistent descriptions that were present. We are happy about the positive feedback regarding publishing this work. Please find the detailed answers to your comments below.

Abstract: Mention new single ice in CAM, but not in the main body. Somewhere in the introduction mention that MM15 is included in CAM.
It is included in the introduction now.

Page 4, line 1: What is the relation ship between mu and lambda? I suggest giving the equation. Page 4, lines 2-6. Can this sentence be simplified? Perhaps split into two for easier reading.
The chapter describing the P3 scheme has been extended. In doing so, these points have been addressed.

Page 4, line 14. It seem that Eidhammer et al (2017) also included the single ice category P3 scheme into the global CAM model. I think the fact that other global models have the same single ice category scheme implemented should be mentioned in the introduction and a short discussion on the difference and similarities between the approach in this paper and the one of Eidhammer et al could be included.
We agree that it is interesting to compare the implementation of the single ice category in CAM by Eidhammer et al. (2017) to ours in ECHAM-HAM. We added therefore the main differences between the study by Eidhammer et al. (2017) and ours in the introduction.

Page 8, line 8. What about deposition freezing at cirrus temperatures, and competition between heterogeneous and homogeneous freezing? Is this effect included in the parameterization by Karcher and Lohmann (2002)?
The Kärcher and Lohmann (2002) scheme includes homogeneous freezing. There is ongoing work in our group to improve the representation of cirrus cloud formation in ECHAM-HAM, including the competition for vapor deposition between homogeneous and heterogeneous freezing and pre-existing ice crystals. When this is ready, it is planned to be included in our scheme.

Page 10, line 2. Should it be S_acc=d_qr/dt|acc instead of S_acc=d_qr/dt|aut?
Yes, thanks!

Page 10, line 2: I suggest including mass for the ice mixing ratio: ice mass- q_i.
Good idea. This has been done.

Page 11, line 16: Is the limit of 0C due to diagnostic rain? I suggest including the reason for the 0C (or actual 5C) limit.
The way we calculate the number of sub-steps has been reworked to be more general and is now temperature-independent.

Page 16, line 23. I suggest adding a comma after . . .in the cloud
Done.

Page 20, line 9. I suggest renaming the section 5.3 with something more descriptive, since single ice category is considered in all the other sections as well.
It is now called 'Limitations of the P3 scheme'. In fact, we renamed all the subsections of chapter 5 to make the story more clear. It goes from validation (5.1) to adaptation for the GCM (5.2) to limitations (5.3).

Page 20, line 12. Remove comma after remember
Page 20, line 14: I suggest reminding the readers of the 4 parameters here. Page 21, line 4: Add . . ..the number concentration in the tail of the. . ...
Done.

Page 23, line 12. I would like to see a short description in how ECHAM6-HAM2 deals with conversion of ice to snow somewhere in the paper. According to the introduction, Morrison and Gettelman (2008) use a threshold size while, while Murakami (1990) base it on accretion and riming rates. On page 4, it is stated that conversion rates dates back to Murakami (1990), while on page 23, line 12 it is stated that the single ice category scheme removes the threshold size parameter. But does Murakami use a threshold size parameter?
This was indeed not consistent. Murakami (1990) assumes a threshold size for snow which is used together with ice particle growth rates to calculate a characteristic time needed to form snow. This time is then converted to a conversion rate. This is now elaborated more clearly in the introduction.